DEVELOPMENT OF ACID/HEAVY METAL-TOLERANT CULTIVARS (DATC) PROJECT

Prepared for:

Clark Fork Symposium
Missoula, Montana
April 14-15, 2000

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ABSTRACT

Current reclamation efforts to revegetate hardrock minelands in western Montana have met with limited success. In the Upper Clark Fork River Basin, for example, there are still vast areas of unvegetated and unproductive land. The majority of native seed currently being used on hardrock mine reclamation projects was developed for coal strip-mine reclamation in the dry, high pH soils of eastern Montana. These plant materials are not adapted to the acid/metalliferous soils commonly found at hardrock mine sites or to the regional climate. The Development of Acid/Heavy Metal-Tolerant Cultivars (DATC) project seeks to address this problem by selecting ecotypes indigenous to western Montana that demonstrate superior tolerance to acid/heavy metal soil conditions. In 1995, two initial evaluation plots were constructed on the Anaconda Smelter Superfund Site. Plant materials in this study were assembled from both wildland collections and commercial seed sources. The plots collectively tested 95 species consisting of 51 grass, 29 forb, 14 shrub, and 1 tree species. After three growing seasons, the superior performing entries were identified. The best performing collections are presently being tested in a comparative evaluation planting (CEP) near Anaconda in comparison to other accessions and cultivars of the same species. Concurrently, 13 grass, 6 forb, and 7 shrub species are being grown at the Bridger Plant Material Center (BPMC) to determine cultural techniques and to increase seed. The results from the CEP and the success of seed production will provide valuable information for the selection of plant materials. Releases will be made through the Pre-Varietal release process. Foundation seed for the releases will be maintained at the BPMC for distribution to commercial seed producers through the Montana and Wyoming Crop Improvement Associations.

INTRODUCTION

Thousands of acres in western Montana affected by hardrock mining and smelting activities are barren or support limited plant cover. Current reclamation efforts using native species rely primarily on cultivars developed for coal strip-mine reclamation in the dry, high pH soils of eastern Montana. The lack of plant materials developed specifically for the acid and/or heavy metal contaminated soils or wastes prompted the initiation of a project to identify, select, grow, and ultimately release plant materials that demonstrate superior adaptation to these sites. The Development of Acid/Heavy Metal-Tolerant (DATC) project's goal is to provide a reliable supply of high quality indigenous seed adapted to hardrock minelands in western Montana.

INITIAL EVALUATION

The Deer Lodge Valley Conservation District (DLVCD) in partnership with the Natural Resources Conservation Service - Bridger Plant Materials Center (BPMC) initiated the DATC project in 1995 with a Reclamation and Development grant from the Department of Natural Resources and Conservation. The project began with the assemblage of seed from wildland collections made at 26 mine-affected sites throughout western Montana. Additionally, seed was procured from commercial seed suppliers. The entries were planted at two initial evaluation plot sites at the Anaconda Smelter Superfund Site.

DATC Site 1 is located east of Anaconda, Montana near the junction of Lost Creek Road and Warm Springs Road. This area has been impacted by aerial fallout from past smelter emissions and the on going re-deposition of fugitive dust. Contaminants such as cadmium, copper and zinc are concentrated in the upper few inches of the soil profile. DATC Site 2 is located on the Opportunity Ponds, approximately 2 miles northeast of DATC Site 1. The Opportunity Ponds were used as a disposal site for mill tailings. These tailings vary in composition but are typically highly acidic and contain high levels of copper, lead and zinc. DATC Site 1 and Site 2 collectively tested 95 species consisting of 220 accessions. Lifeform distribution was 51 grass, 29 forb, 14 shrub and 1 tree species.

Results from the initial evaluation planting identified the best performing cultivars currently available on the market, as well as the best performing indigenous species. Subsequently, many of the superior indigenous species were collected on a larger scale. These collections were accessioned, cleaned, and put into seed production at the BPMC.

Seed and Plant Production

To improve the quality and quantity of indigenous seed, successful seed production techniques must be developed. Seed production is being conducted via two methods- direct field planting and container production. Large seed lots of forbs and grasses are field-grown. Small seed lots are container-grown in a greenhouse or hoophouse.

Direct-seeded fields are established by drilling 3-foot spaced rows at a rate of ~30 PLS per foot. Fields are furrow irrigated, cultivated, and sprayed using standard farming procedures. The

forbs require more intensive treatment. Many forbs have hard seed coats requiring chemical or physical scarification. Forbs species are commonly seeded in the late fall and germinate the following spring. After emergence hand-rouging or spot spraying is required to minimize weed invasion. Depending on the plant type and the size of field, seed is harvested using a variety of methods. Smaller fields are commonly harvested by hand stripping. Larger fields are harvested using a swather equipped with a canvas catch basin or with a small plot combine. The harvested material is then spread on tarps to afterripen for 1 to 2 weeks.

Container production is used with small seed lots and on all of the woody accessions. Four cubic inch containers are used for the forbs and lower growing grasses. Ten cubic inch containers are used for woody material and the tall, fast growing grasses. Sunshine® mix #1-(a general use mix) is employed as the growing media. The forb and woody species requiring pretreatment are sown, watered and prechilled in a walk-in cooler at ~34°F (~1°C) and/or warm stratified in the greenhouse at ~82°F day/62°F night (~28°C/18°C) for a prescribed duration. The grass species generally require a 10-day cold chill. Grasses are sown and transferred to the hoophouse in early March. The containerized material is then transplanted in mid-May. The transplanting is done with a Mechanical Transplanter®. Herbaceous plant material is spaced ~1 foot within row and 3 foot between rows. Woody plant material is spaced ~6 feet within row and 8 to 12 feet between rows. Production techniques are still in the experimental stage and will continue to develop as work progresses.

Currently, there are 12 grass species (15 accessions), 6 forb species (7 accessions) and 6 shrub species (6 accessions) in ~3.5 acres of seed increase blocks as described in table 1. These accessions, with the exception of alpine bluegrass *Poa alpina*, were collected at various sites within the Anaconda Smelter Superfund Site. Most of these species are native to western Montana and are adapted to a range of vegetation zones from the plains to alpine. Redtop *Agrostis gigantea* and Canada bluegrass *Poa compressa* are not native, but are valuable for the reclamation of contaminated pastureland. The initial objective of seed production is to provide seed for further testing and to determine the best production methods since many of these species have not previously been cultivated. Ultimately, the purpose of seed production is to provide a supply of foundation seed for distribution to commercial seed growers once the accession is released.

RELEASE PROCEDURE

The plant materials developed for hardrock minelands in western Montana will be released as “Source-Identified” or “Selected” class germplasm through the Pre-Varietal release process. Traditionally, plant materials were solely released at the Cultivar level. Cultivar releases require lengthy testing and focus on plant materials that are widely adapted and have outstanding and/or unique characteristics. In recent years, alternative release procedures have been developed to accelerate the release of plants that serve a limited geographic area or address a special resource need. The Association of Official Seed Certifying Agencies (AOSCA) publishes Pre-Varietal Germplasm standards for certification of germplasm accessions. These Pre-Varietal release standards offer a reliable way for release agencies to offer seed of varieties, races or ecotypes to buyers with genetic identity maintained in field production, conditioning, and storage. Standards also insure accurate original collection site (source) information. This enables revegetation planners to better select plant materials for specific sites.

Source-Identified class releases require only that the geographical location of the original collection site be defined and that the germplasm is representative of the population of the wild stand. Selected class releases require that enough testing be conducted to prove that an

accession shows superior traits or shows promise of superior performance when compared to other accessions at a common site. The DATC project seeks to release materials with the greatest amount of testing reasonable for the application purpose. Due to the longer interval for woody plant development, shrub species will initially be released as Source-Identified. Wild collected shrub collections will be grown under cultivated conditions in seed orchards at the BPMC in order to provide a high quality and quantity of seed. The cultivation of wildland seed under controlled conditions improves seed viability, provides a reliable supply of seed, and is less costly. As part of this proposal, woody accessions will be comparatively tested at the Anaconda Smelter site and upgraded to the Selected level if supporting data indicates superiority. By initially releasing the material at the Source Identified level, the plant material is made immediately available to the commercial seed market. All grass and forb species will be released at the Selected level. To accomplish this, a Comparative Evaluation Planting (CEP) was seeded in the late-fall of 1999 at an acid and heavy metal contaminated site approximately 2 miles east of Anaconda.

COMPARATIVE EVALUATION

The CEP plot site is contaminated by past smelter emission fallout of heavy metals and sulfides and has a pH of 4.5 and high levels of arsenic copper and zinc. The CEP will further test the promising collections by comparing the acid/heavy metal tolerance of multiple accessions of each species. Evaluation of the entries in the CEP will begin in the spring of 2000. Plant materials selected for release will be chosen based on: 1) performance in the CEP, 2) commercial seed production potential, 3) nutritional forage safety, and 4) ability to initiate and/or accelerate the process of succession.

PROJECT FUTURE

The end products of the project will be the release of several western Montana ecotypes that either have proven superior tolerances to acidic/heavy metal contaminated soil or exhibit traits desirable for reclamation. Forthcoming CEP performance data will provide important information on tolerance and adaptation. Future field trials will determine inter-species compatibility and proper seed blends. A Planting Guide that documents adaptation, uses, compatibility, establishment, etc will accompany each release. Plant releases are anticipated to begin in 2001.

View of Opportunity Ponds looking at the Southwest.

Potentilla hippiana being grown for seed at the Bridger Plant Materials Center.

Collecting Heuchera parvifolia above the Moto-X northeast of Anaconda.

Clark Fork SYMPOSIUM

Transplanting containers using a Mechanical Transplanter.

Clark Fork SYMPOSIUM

Heuchera parvifolia growing in contaminated soil near Anaconda.

Sphaeralcea coccinea growing in contaminated soil near Anaconda.